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§4. Time Evolutions of the Ion Temperature in the Edge Transport Barrier (ETB) Operations in CHS

Nishimura, S., Okamura, S., Minami, T., Akiyama, T., Nagaoka, K., Yoshimura, Y., Ida, K., Isobe, M., Suzuki, C.

As previously reported [1], the main feature of the edge transport barrier (ETB) in CHS is the change of the density profile after the L→H transition, and the electron temperature profile does not change clearly at the transition. Here we show time evolutions of ion temperature profiles in the ETB operations. Fig.1 shows the ion temperature. The magnetic configuration is that with the magnetic axis position of R_{ax}=92.1cm and a quadrapole magnetic field of B_q=0%. Although this configuration is not the standard one (B_q=−50%), it is often used to investigate the transition phase. Two neutral beams (30-40kV, 800kW×2) heated the plasma, and a strong gas puffing increases the line averaged electron density (n_e~(2-4)×10^{13}cm^{-3}). The L→H transition occurred at t≅75ms in these example shots. It seems that the ion temperature was already increased to be $T_i(0)$≅400eV in the starting phase of t~50ms before the transition and retained this value after t>70ms. This time evolution is typical one in previous NBI heated plasmas without the L→H transition. Since the central electron temperature is also $T_e(0)$≅400eV before and after the transition, the both of the central electron and ion temperatures retain the relation $T_e(0)$ ≅ $T_i(0)$ during the transition. However, the time resolution of ion temperature is not as good as the electron temperature measured by YAG Thomson scattering, since the charge exchange spectroscopy (CXS) system used here to measure the ion temperature utilizes the integration of 20ms. Therefore, we are investigating various plasma shots having different transition time to confirm this tendency in that ion temperature is increased only in the starting phase and retain the same value after the transition. Fig.2 shows results in the other shots in which the transition occurred at t≅85ms. The magnetic configuration and heating scheme are almost identical to those in Fig.1. It seems that the time evolution measured by the CXS is not sensitive to this shift of ±5ms, and therefore the temperatures can be considered to be almost steady at the transition. The impurity poloidal rotation approximately indicating the radial electric field also is almost steady in the core region of r/a≤0.9[2].

Another feature of the ion temperature profile in the steady state is a relatively flat profile having a high edge temperature of T_i≈100eV at the edge of measured region (R≅1.06cm). In contrast to this $T_i(r)$ profile, the $T_e(r)$ profile is a relatively peaking one with a low edge temperature of T_e (r/a≈0.8)≈50eV [1]. This ion temperature suggests that a "pedestal" or a "barrier" structure exist near the edge and their structure may change at the transition. Since we have already found such a "barrier" structure of ΔT_i ≈ 100eV and ΔR ≈ 1cm in the N-ITB operations [3] with this measurement, the detail structure of the edge profile is a future theme. Since these CXS results in FY2004 were obtained by a vertical viewing at a vertically elongated section, the diameter of the chord 7mm was the dominant factor limiting spatial resolution and corresponded to $\Delta r/a$≈0.07. To investigate the structure at the edge region of 0.9≤r/a≤1 also by spectroscopic methods, a vertical viewing at a horizontally elongated section is planned in FY2005. A possibility for a toroidal non-uniformity of the edge plasma flows [2] in non-symmetric toroidal plasmas is another theme in FY2005 using this method.

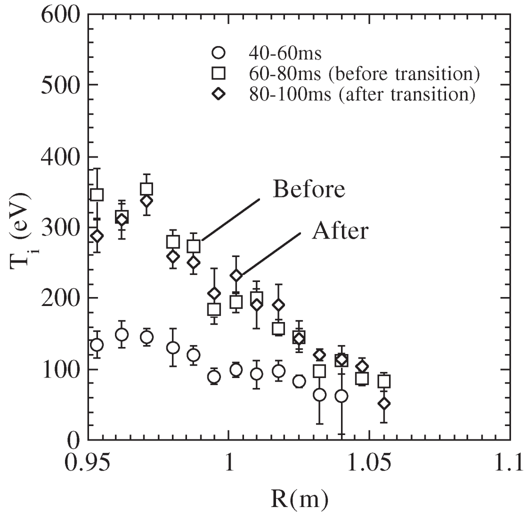

Fig.1 The ion temperature in ETB shots #114115-114121. In these shots, the transition occurred at t=75ms.

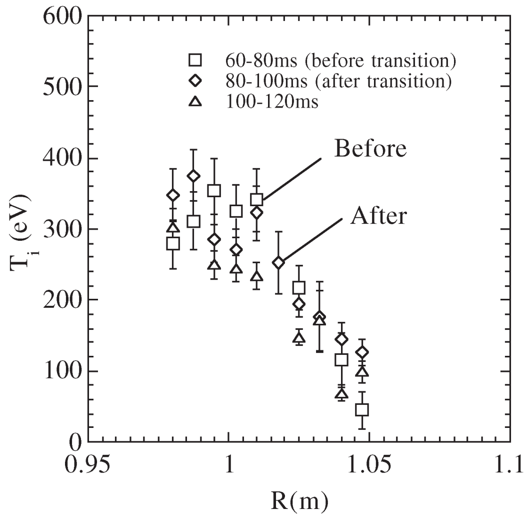

Fig.2 The results in ETB shots #117612-117614 in which the transition occurred at t=85ms.

References

[1] Okamura,S., et al., in 20th IAEA EX8-5Ra (2004)

[2] Nishimura,S., et al., in this report

[3] Minami,T., et al., Nucl.Fusion **44**, 342 (2004)